Abstract

Hybrid power plants consisting of a solid oxide fuel cell (SOFC) and a gas turbine (GT) are an interesting field of research due to the expected high electrical efficiency, fuel flexibility and part-load good performance.

At DLR (German Aerospace Center), a demonstration SOFC/GT hybrid power plant is being built and its operation is being simulated by means of a global system model that does not account for heat losses. The system models available in literature are adiabatic as well. Though, considering heat losses during stationary operation allows for an improved prediction of the operating range as well as for the prevention of undesired operating problems. Similarly, investigating the heat capacity of the system during transient processes allows for the examination of new possible operating strategies.

In the present thesis, the energy losses from the hybrid power plant are identified and modeled, in order to integrate the global system model and enhance its accuracy while keeping a low computational time. Due to the complexity of the system, the high number of components and the loop-type interactions between them, a high computational speed is required to analyze a large number of operating points and boundary conditions.

For this purpose, different modeling strategies are compared. Various multi-dimensional models for the evaluation of heat losses from the components of the hybrid power plant are created in the MATLAB environment for both stationary and transient operation. The real system parameters are implemented by building a database for material properties and components geometries.

The results obtained with the different models are then compared in order to choose the paradigm that gives the lowest computational time while maintaining a feasible accuracy. Eventually, a zero-dimensional model is selected for the implementation in the global system simulation, as it meets those requirements.

Therefore, a complete set of fast and reliable sub-models for stationary and transient simulations is available to carry on future studies and thoroughly investigate the operation of the SOFC/GT hybrid power plant.